Nanostructured Thermoelectric Oxide Materials for Effective Power Generation from Waste Heat

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A large amount of thermal energy that emitted from many industrial processes is available as waste heat. It is difficult to reclaim this heat due to the dispersed nature and relative smallness of its sources. Thermoelectric conversion can offer a very promising method to overcome these difficulties by converting heat directly into electricity. However, the requirements for this task place in the materials are not easily satisfied by the conventional thermoelectric materials. Not only they must possess a high thermoelectric performance, they should also be stable at high temperatures and be composed of nontoxic and low-cost elements, and must be able to be processed and shaped cheaply. Oxides are among the strongest candidate materials for this purpose, and recently they have been intensively investigated and developed [1-5]. In this report, the development progress of two state-of-the-art *p*-type $Ca_3Co_4O_{9+\delta}$ and *n*-type doped-ZnO oxide systems is presented. The thermoelectric generator (TEG) devices based on these oxide materials were fabricated, examined, and demonstrated with various output applications. At a ΔT = 500 K, the maximum output power of our TEG composed of 32 *p*-*n* couples reached 1W, which is among the best one so far and is enough for a practical application such as phone charge or GPS device (see Fig. 1).

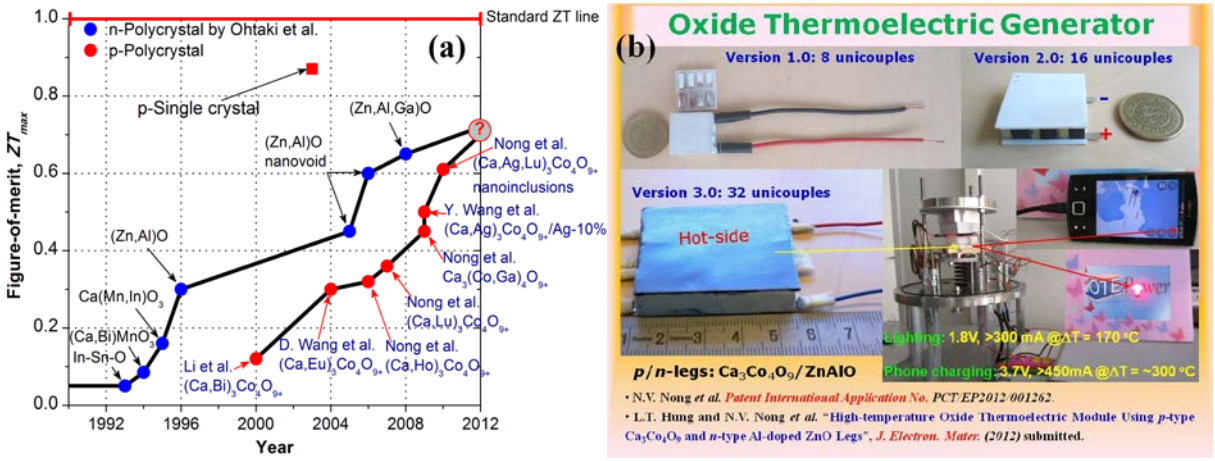

Fig. 1. a) The historical progress of achievements for the typical *n*- and *p*-type oxide thermoelectric materials over the years and b) demonstration of high temperature oxide thermoelectric generators.

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